ELSEVIER

Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia - Social and Behavioral Sciences 82 (2013) 81 – 86

Procedia
Social and Behavioral Sciences

World Conference on Psychology and Sociology 2012

Developmental Learning: Theoretical and Empirical Considerations

Elena V. Volkova [a] *

[a] The Institute of Psychology of Russian Academy of Sciences, 13/1 Yaroslavskaya street, Moscow 129366, Russian Federation

Abstract

The present work convincingly demonstrates a wide field of the differentiation-integration theory of development for elaborating rational programs of education that provides not only efficient mastering of knowledge, but entails the development of general and special abilities of schoolchildren. The techniques of assessment of quality of knowledge built on our theory allow us to define a zone of proximal development and thus to organize the education process that leads to intellectual development of every pupil.

Selection and peer review under the responsibility of Prof. Dr. Kobus Maree, University of Pretoria, South Africa.

Keywords: Developing Teaching, The Principle of Systems Differentiation and Integration, Development of General and Special Abilities, Conceptual Structures of Chemistry;

1. Introduction

The problem of human development is an important goal of society. We all want our children to develop mental abilities in the process of education. But what must we do in order to organize developing teaching? Contemporary considerations of this question are permeated by various complex issues and themes that continue to beg for conceptual refinement and empirical systematization.

For example, one of the most widespread definitions of development consists in defining development as changes in observed behavior across age. To be sure, development entails some change over time. But nevertheless development and change are not equivalent. Overton has absolutely correctly noticed that: “Although the focus on change is straightforward and noncontroversial, major problems arise when considering whether every type of change should be accepted as developmental and, if not, what is the peculiar nature of change we call developmental” (Overton, 2006, p. 22). Within the development-as-change-over-time paradigm,

* Corresponding author: Elena V. Volkova. Tel.: +7-903-539-5532
E-mail address: volkovaev@mail.ru

Selection and peer review under the responsibility of Prof. Dr. Kobus Maree, University of Pretoria, South Africa.
doi:10.1016/j.sbspro.2013.06.228

developmental psychology has focused on dividing human beings into age ranges and life-phases. These stages have become reified as milestones for describing typical behavior of person. Thus, much of developmental psychology has turned to the catalogue of forms of behavior at different ages and in different life-phases: infants do A, children do B, adolescents do C, emerging adults do D, young adults do E, middle adults do F, and old adults do G (Raeff, 2011).

However, what happens between the age-based catalogue of achievements or milestones? We should conclude that development as the psychological reality has disappeared. It was dissolved in the various empirical studies.

Other side of the problem of developmental learning consists in the fact that we are knowledgeable of a zone of proximal development, which refers to the functions that have not yet matured but are in the process of maturation. This zone is often measured as the difference between performance before and after instruction. In this way, we estimate the individual's ability to learn. But what does it give us for the organization of developmental teaching except for the fact that one individual acquires knowledge easier than others? What shall we do to organize learning in a zone of proximal development?

Developmental scientists of the past century left many questions unanswered.

The goal of the current study is to argue that the organization of education according to the principle of systems differentiation and integration of mental structures as a substratum of mental development offers a clear way for the solution of this problem. Ultimately, it is argued that defining development in terms of differentiation and integration offers a systematic framework for distinguishing between change and development (Raeff, 2011), between mastering of knowledge and development of abilities in the process of education (Volkova, 2011).

2. Methodology

The research is based on two interrelated premises of the differentiation-integration theory of development (DI theory):

1) the general universal law or principle of organic systems development is the principle of systems differentiation and integration. It holds that development involves moving from a state of relative globality and undifferentiatedness towards states of increasing differentiation and hierarchic integration (Werner, 1957; Chuprikova, 2007);

2) the idea that multidimensional representative cognitive structures in long-term memory are substratum of cognitive development including the development of general and special abilities (Vekker, 1981; Kholodnaya, 2002; Chuprikova, 2007; Volkova, 2011).

These theoretical ideas are not new, and they have been addressed in various ways since developmental psychology emerged as an academic discipline in its own right. Broadly speaking, if we look at the papers of ancient thinkers (Ancient Greece, China, India and others (even the Bible)), we can find some prototypes of DI theory. But these ideas are global and syncretic. They do not mean anything but indicate a direction of thinking.

In spite of the fact that there are scholars all over the world who continue to use and extend DI theory of development, this theory has largely been forgotten by mainstream developmental science. There are various reasons for the fate of DI theory, a discussion of which is beyond the scope of this paper. Nevertheless, recent theoretical and empirical analyses further suggest that DI theory deserves renewed attention due to their utility both for analyzing human development, for elaboration of theoretical constructs and for elaboration of rational programs of education.

3. Research design

To organize developing teaching it is necessary to understand mind work, to analyze relations of subjective experience of person and culture, their structure and their dynamic. The person development and evolution of science are conceptualized as part of the whole; one cannot deal with one aspect of the whole without treating the other.

3.1. Evolution of chemical knowledge

The historical analysis of evolution of chemical knowledge allowed us to reconstruct a chemical picture of the world fixed in culture and to enucleate the process of forming of chemical concepts.

In the antique period of development of chemistry we can find the prototypes of key concepts which are a basis of modern science such as element, atom, bonding, compound, chemical phenomena, chemical reaction and structure. The main ideas which are necessary for definition of the concept "element" such as atom, atom characteristic (weight, size) and limitation of the number of atom forms had been put forward by ancient scholars. Thus, the element is a set of atoms of a certain kind. But as the concept "element" has not been separated from concept "body", "substance", "a modular condition", the definition of this key chemical concept lasted for a long time as a clarification of an objective chemical picture of the world from the subjective views of scientists of different epoch took place. Only then the possibility of integration of these concepts, possibility to ascertain the concept "element" appeared.

The historical analysis of the facts (Table 1) shows that the process of evolution of chemical knowledge corresponds to the principle of systems differentiation and integration: chemical properties of substance are determined by its composition, then composition and structure, then composition, structure and all kinetic system as a whole.

Table 1. Evolution of conceptual systems of chemistry

Time of appearance	Doctrine	Properties of substance are determined	The basic theses of the doctrine
Fourth century BC	composition	• composition	Elements as indecomposable further bodies from which all «the mixed bodies» (compounds) consist. Properties of substance are determined by its composition, i.e. that of what elements and in what parity the substance was formed.
First half of XIX-th century	structure	• composition • structure	Properties of substance are determined by the structure of a molecule, i.e. by its element structure, order of connection of atoms among themselves and their arrangement in space.
Second half of XIX-th century	chemical process	• composition • structure • organization of the system of reacting substances	Properties of substance are determined by its composition, structure and the system organization in which this substance exists.
Second half of XX-th century	chemical evolution	• composition • structure • organization of the system of reacting substances • ability to undergo irreversible evolutionary changes	In strongly nonequilibrium states substance is capable of perceiving distinctions in an external world and of taking them into account in the process of functioning.

3.2. The comparative analysis

Understanding of developmental learning can be facilitated by revealing of relation between evolution of chemical knowledge and organization of the concept "substance" in different groups of participants.

3.2.1. Method

We have constructed a special test to estimate chemical abilities (GreatChemist).

The purpose of the test is to measure the choice reaction time and the quantity of errors. The formulas of chemical compounds appear on the screen in a random order:

$HCOO – (CH_2)_4 – COOH$, $(NH_4)_2SO_4$, Mn_2O_7, Rb_2O, Cu, C, Co, Cl, N≡N…

The participant must divide these stimuli into groups according to the instruction: into two groups (global level), into 4 groups (basic level), into 15 groups (detailed level).

3.2.1. Findings

As we can see from the Table 2, the time of chemical stimulus-objects distinction decreases in all groups of participants in the process of age development and chemistry assimilation. The more successful is the participant in studying of chemistry the greater is number of levels of concept “substance”. The older and more proficient is the participant the greater is number of levels of concept “substance”. Thus, the development of a concept “substance” occurs as moving from the global level through the basic level to the detailed one.

Comparing these findings (Table 1, 2) we could conclude that there is an analogy between the development of the conceptual structure of chemistry in individual experience and the evolution of chemistry knowledge. Their development derives from a state of relative globality and undifferentiatedness towards the states of increasing differentiation and hierarchic integration.

Table 2. Time (T, sec) and accuracy (n - errors) of chemical stimulus-objects distinction in different groups of participants

Participants	**Levels of the organization of the concept “substance”**					
	Global level		Basic level		Detailed level	
	T1, [sec]	n1	T2, [sec]	n2	T3, [sec]	n3
Less successful						
14-year-olds (56 persons)	76.83	5.05	135.65	10.36	400.39	27.51
15-year-olds (60 persons)	48.84	1.7	88	6.2	313	19.82
19- year-olds (260 persons)	39.43	1.52	49.29	0.27	153.1	6.97
More successful						
14-year-olds (18 persons)	53.16	2.83	105	2.16	358.3	15.9
15-year-olds (14 persons)	42.14	1.5	62.57	1	255.78	8.28
19-year-olds (68 persons)	36.5	0.31	46.53	0.08	122.75	3.6

3.3. The formative experiment

The purpose of the formative experiment (Volkova, 2011) is to form key conceptual relations of chemistry conformable with the evolution of chemical knowledge. The educational program provides the transition from operation by global, not differentiated images of chemical reality to the operation by more and more differentiated elements, properties and relations.

3.3.1. Methods

The WISC test, a complex of techniques of estimation of special chemical abilities (“Great chemist” and others) and chemical academic achievement were used. The control group consisted of the schoolchildren of the same age but studying chemistry without applying the evolutionary method.

3.3.2. Findings

The findings of the formative experiment (Table 3) confirm the conclusions of the previous research (Table 2). Learning efficiency indicators in the experimental group are higher than in the control group.

It is necessary to emphasis that significant increase in the indicators of abilities is observed only on the condition when the detailed level is formed (experimental group), meanwhile the decrease in the indicators of abilities is observed in the other cases. Thus, not any teaching leads to the development of special abilities but only such a teaching that is organized according to the principle of systems differentiation and integration and provides the formation of the detailed level of chemical concepts.

It was shown that the formation of conceptual structures providing successful mastering of chemical knowledge affects the development of both verbal and nonverbal intelligence during educational experiment (Volkova, 2011). That is, the purposeful development of special chemical abilities entails the development of intelligence.

Table 3. Dynamics of formation of concept "substance" and chemical abilities in the conditions of educational experiment

Indicators of the organization of conceptual structures of chemistry and special chemical abilities			**Experimental group** 14 years	15 years	**Control group** 14 years	15 years
Less successful participants						
Organization of the conceptual structures	Global level	T1, sec	86.58	46.15***	100.22	45.87*
		n1	6.58	1.5**	5.88	2.28
	Basic level	T2, sec	182.66	88.85***	130.11	91.09*
		n2	16.75	7.7*	6.44	5.42
	Detailed level	T3, sec	448.83	276.26**	390.55	355
		n3	33.91	19.78***	25.88	23.28
Special chemical abilities	"Chemical" intuition, points		3.26	5.07	4.61	3.13
	Long-term memory for the chemical information, %	simple information	59.6	70.2	77.7	72.3
		complex information	17.8	40.4**	42.3	38.2
	Interest in the study of chemistry, points		1.07	0.55	4.66	1.8
More successful participants						
Organization of the conceptual structures	Global level	T1, sec	64	31*	84	50*
		n1	2.7	0.5	3.4	2.16
	Basic level	T2, sec	149	47*	108	79*
		n2	2.33	0.83	3.76	2.66
	Detailed level	T3, sec	320.77	147.33**	371.73	342.75
		n3	19.33	4**	21	15.16*
Special chemical abilities	"Chemical" intuition, points		5.04	10.9***	5.86	4.25
	Long-term memory for the chemical information, %	simple information	87.8	97.5	84.5	80.8
		complex information	54.3	95.8**	61.3	62.5
	Interest in the study of chemistry, points		1.18	5.66**	4.16	2.38

p <0,05; p**<0,01; p***<0,001*

4. Conclusions

The processes of development of scientific knowledge, the formation of conceptual structures and development of general and special mental abilities correspond to the principle of systems differentiation and integration. It holds that development involves moving from a state of relative globality and undifferentiatedness towards states of increasing differentiation and hierarchic integration.

The present work convincingly demonstrates a wide field of the differentiation-integration theory of development for elaborating rational programs of education that provides not only efficient mastering of knowledge, but entails the development of general and special abilities of schoolchildren.

The techniques of assessment of quality of knowledge built on our theory allow us to define a zone of proximal development and thus to organize the education process which leads to intellectual development of every pupil.

References

Chuprikova, N. I. (2007). *Psychology of cognitive development: Principle of differentiation.* St.-Petersburg. (In Russian).

Kholodnaya, M. A. (2002). *Psychology of intelligence: paradoxes of research.* St.-Petersburg. (In Russian).

Overton, W. F. (2006). Developmental psychology: Philosophy, concepts, methodology. In R.M. Lerner (Ed.), *Theoretical models of human development* (Handbook of child psychology, Vol. 4, pp. 18-88). New York: Wiley.

Raeff, C. (2011). Distinguishing between development and change: Reviving organismic-developmental theory. *Human Development, 1.*

Vekker, L. (1981). *Mental processes.* Leningrad. (In Russian).

Volkova, E. V. (2011). *Psychology of special abilities: differentiation and integration approach.* Moscow: IP RAS. (In Russian).

Werner, H. (1957). *Comparative psychology of mental development.* New York.